Micromagnetic simulation of magnetic spectra in permalloy antidot array

C. P. Mu, W. W. Wang, B. Zhang, Q. F. Liu, and J. B. Wang

I. Introduction

In recent years, array of magnetic nanoelements have received a great deal of attention due to their potential applications in various devices. Many patterned magnetic nanostructures, such as array of nanospheres, nanowires, and nanotubes, have been investigated widely. Antidot arrays by introducing periodic holes into a continuous magnetic film have shown novel magnetic configurations. In this respect, the static properties of antidot array have been the studied mostly [1], furthermore, the dynamic properties are of paramount interest for applications. In this paper, we investigate dynamic susceptibility spectra of permalloy antidot array and isolated antidot by using three-dimensional Object Oriented Micromagnetic Framework [2] with extension for two dimensional periodic boundary condition (2-DPBC).

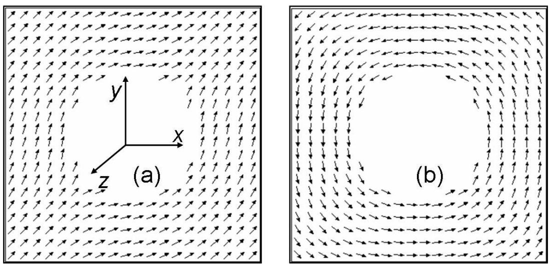

Fig. 1. The equilibrium magnetizations of the permalloy antidot array (a) and one isolated antidot (b) with d=50 nm

II. METHOD AND RESULTS

The antidot array was obtained from extension for 2-DPBC. We assume that the same magnetic configurations of element will be infinite repeated for two directions, such as, x and y axes in this paper. The element of antidot array is characterized by the thickness t =20 nm, radius r=25 nm and distance d rang from 20 nm to 60 nm. An isolated antidot with the same configuration was also investigated for reference. Material parameters used are those typical of permalloy. Fig.1 (a) shows the equilibrium magnetization of element of permalloy antidot arrays. A vortex configuration existed in isolated antidot as expected has bee seen in Fig.1 (b). A small exciting field was applied parallel to the x direction. The investigated systems exhibit two major resonance peaks for isolated antidot (Fig.2). The low resonance frequency results from the four corner regions

Key Laboratory for Magnetism and Magnetic Materials of Ministry of Education, Lanzhou University, Lanzhou 730000, People's Republic of China E-mail: wangjb@lzu.edu.cn

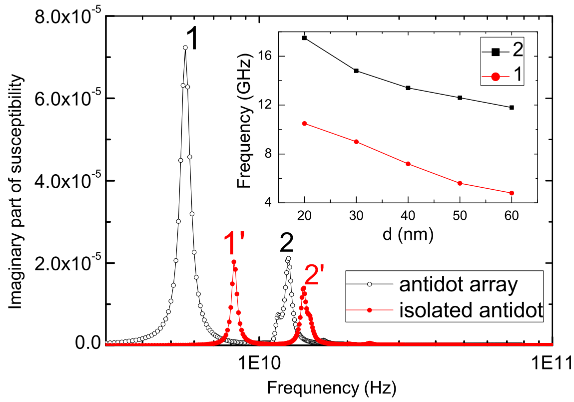

Fig. 2. The imaginary part of susceptibility of the antidot array (open circles) and one isolated antidot (closed circles) with d=50 nm. Inset: distance dependence of resonance frequencies for two major modes of antidot array.

whereas the high resonance frequency corresponding to a volume mode is ascribed to spin zone with uniform magnetization perpendicular to the external field. These results are also observed with lower frequencies for antidot array. Due to the effective field of z direction for antidot array are low than one isolated antidot, the resonance frequencies of one isolated antidot are higher than antidot array's. The high intensity of peak 2 shows a resonance frequency of 12.6 GHz, which comes from the spin coniguration area with high M_y. The intensive resonance peak 1 (5.6GHz) with low frequency can be viewed as a stripe domain mode. The frequencies evolution of resonance modes above for antidot array was investigated as a function of d. Both of resonance frequencies decrease with the d increasing.

III. CONCLUSION

Dynamic susceptibility spectra of the permalloy antidot array with 2-DPBC are investigated. Due to the non-uniform magnetization structure, two main resonance modes are found. A predominant resonance peak with a low frequency results from stripe domains. Another type of mode is associated with volume mode.

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References

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[2] M. J. Donahue and D. G. Porter, OOMMF User's Guide, Version 1.2a3 (2002) (http://math.nist.gov/oommf).